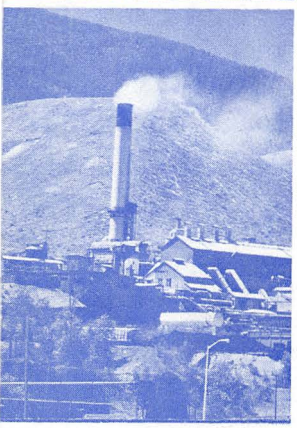
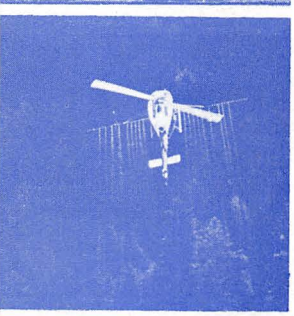

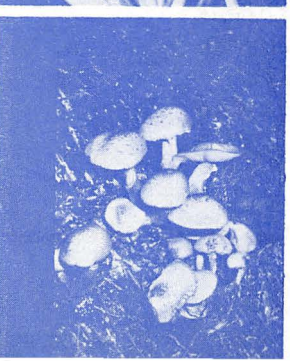

FOREST INSECT & DISEASE MANAGEMENT

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STATUS OF MOUNTAIN PINE BEETLE INFESTATIONS GLACIER NATIONAL PARK AND GLACIER VIEW RANGER DISTRICT FLATHEAD NATIONAL FOREST, MONTANA, 1977

by

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ABSTRACT

Mountain pine beetle populations developed to epidemic level in Glacier National Park in 1972. Buildup ratio of old to newly attacked trees was 1:1.8 from 1976 to 1977. More than 12 million trees are infested on 142,871 acres. Buildup ratio is expected to exceed 1:3 from 1977 to 1978. Management with fire is recommended to reduce potential hazard and to create a mosaic of young stands within the extensive areas of large timber. In high use areas, all green lodgepole pine 7 inches d.b.h. and larger which are to be retained should be treated with the protective spray Sevimol-4®. Hazard trees should be removed.

More than 1.5 million trees are infested on about 27,000 acres on the Glacier View Ranger District. Buildup ratio from 1976 to 1977 exceeded 1:5, and is expected to exceed 1:5 from 1977 to 1978. An accelerated program of logging infested and high risk trees is recommended for high hazard stands. Silvicultural methods for management of various stands are discussed.

INTRODUCTION

Mountain pine beetle, Dendroctonus ponderosae Hopk. populations developed to epidemic level in lodgepole pine, Pinus contorta var. latifolia Engelm., stands in Glacier National Park in 1972. Since then, number of trees killed and acres infested have increased yearly (table 1). By 1974, large groups of infested trees were detected at Starvation and Quartz Ridges, and between Camas and Dutch Ridges (fig. 1 - attached map).

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Table 1--Acres infested and number of infested trees/acre, Glacier National Park, and Glacier View Ranger District, Flathead National Forest, Montana, 1972-1977

Year	Glacier National Park		Glacier View Ranger District	
	Acres infested	Trees/acre	Acres infested	Trees/acre
1972	1,180	4.9	--	--
1973	3,600	10.9	--	--
1974	4,630	32.6	--	--
1975	13,354	19.3	80	6.1
1976	103,887	46.6	1,213	10.3
1977	142,871	76.7	27,610	55.7

In 1975, epicenters developed on the north side of Kintla Lake, Bowman Creek, and the infestation spread from Quartz Ridge south to Logging Creek. Small scattered infested groups of trees were detected in the Anaconda Creek drainage and on Dutch Ridge. Also, a new outbreak occurred in Lower Whale Creek on the Glacier View Ranger District, Flathead National Forest (fig. 1).

In 1976, epidemic beetle populations occurred from the Canadian border south to Camas Ridge in Glacier National Park. Groups of "faders" (beetle-killed trees) ranging from 10 to 500 trees/group occurred from Coal Creek north to Mud Lake on the Glacier View Ranger District. About 1,200 acres were infested on National Forest lands (fig. 1).

In 1977, the infestation spread east in all major drainages on the west side of Glacier National Park, and south to Park Headquarters, and covered 142,871 acres. The infested area increased to 12,913 acres of National Forest, and 14,697 acres of State and private land from the Canadian border south to Big Creek Work Center, Glacier View Ranger District (fig. 1).

The frequency of mountain pine beetle epidemics appears to be directly related to site quality, tree age, tree diameter-phloem thickness distribution within the stand, and elevation and latitude (Amman 1969; Amman 1972; Amman et al. 1977; Cole 1973). Stands on better sites become susceptible faster than those on poor sites. Infestations seldom develop in lodgepole stands <60 years old. In stands 60-80 years old, a larger proportion of the trees are reaching phloem thickness/tree diameters conducive to outbreak development. Stands >80 years old have the greatest hazard for outbreak potential. During the course of an epidemic, the beetle kills proportionately more large than small diameter trees, and usually kills the

largest trees during each successive year. Beetle production is less in trees in dense stands because they usually have thinner bark and phloem, and thus dry out faster, resulting in brood dessication (Cole 1974, 1975; Amman 1977). As larger diameter trees (>8 inches d.b.h.) containing thick phloem are depleted from the stand, infestations begin to decline (Amman et al. 1977; Cole and Amman 1969; Safranyik et al. 1974).

To obtain estimates on infestation intensity and potential for increase, ground surveys were conducted in four areas in Glacier National Park and 12 areas on the Glacier View Ranger District during September 1977.

METHODS

Tree and volume loss estimates and buildup ratios/year were based on 160, 1/10-acres plots located on lines at 5-chain intervals in 16 drainages. A hypsometer was used to determine trees to be tallied within plots. All green and infested trees were placed into one of the following classes:

0 = Healthy
1 = Unknown or natural mortality
2 = Current year's beetle attack
3 = 1-year old attack
4 = 2-year and older beetle attack
5 = Unsuccessful attack

Heights were recorded on each of two tree species/plot for estimating volume loss. Data were analyzed by the computer program INDIDS (Bousfield 1977). Data were used to determine buildup ratios/year; for predicting additional tree mortality in 1978; and to provide forest managers with some indication as to which drainages might be high hazard areas for tree mortality in 1978.

RESULTS

Infestation intensity by year is shown in tables 2-3.

In areas surveyed in Glacier National Park, average number of infested trees/acre was 19.3 in 1975, 46.6 in 1976, and 76.7 in 1977. Volume killed averaged 194 bd. ft./ac. in 1975, 1,088 bd. ft./ac. in 1976, and 6,553 bd. ft./ac. in 1977. About 3.5 percent of the lodgepole pine was killed in 1975, 17 percent in 1976, and 57.5 percent in 1977, a total of 78 percent for the 3-year period. Of the total stand killed, 2.7 percent was killed in 1975, 13.6 percent in 1976, and 46 percent in 1977, totaling 62.3 percent. Buildup ratio was 1:2.4 from 1975 to 1976, and 1:1.8 from 1976 to 1977. Based on plot data, 5,782 trees were killed in 1972, 39,240 in 1973, 150,938 in 1974, 257,732 in 1975, 4,841,134 in 1976, and 10,943,918 in 1977, totaling 16,238,744 trees that have been killed since 1972.

On the Glacier View Ranger District, number of infested trees increased from 6.1/ac. in 1975, to 55.1/ac. in 1977. Volume killed averaged 444 bd. ft./ac. in 1975, 950 bd. ft./ac. in 1976, and 3,316 bd. ft./ac. in 1977. Of

Table 2--Summary of mountain pine beetle infested stands, Glacier National Park, 1975-1977

Area	D.b.h.	Trees killed/acre			Volume killed/acre (bd. ft.)			% lodgepole pine killed			% stand killed		
		1975	1976	1977	1975	1976	1977	1975	1976	1977	1975	1976	1977
Kintla Lake	5-11.9	5	--	78	--	--	4,713	2	--	39	2	--	35
	>12	1	--	19	140	--	2,724	5	--	83	3	--	57
	Total	6	--	97	140	--	7,437	2	--	44	2	--	38
Bowman Creek	5-11.9	2	9	25	121	696	1,403	4	16	54	2	8	30
	>12	1	4	17	145	801	2,405	5	17	84	2	8	40
	Total	3	13	42	266	1,497	3,808	4	16	64	2	8	34
Teepee Flat	5-11.9	8	57	69	108	1,005	1,934	5	37	71	5	36	67
	>12	--	5	24	--	463	3,372	--	15	95	--	14	87
	Total	8	62	93	108	1,468	5,306	4	34	81	4	32	77
Camas Creek	5-11.9	8	--	29	262	--	2,130	6	--	23	5	--	20
	>12	--	2	46	--	300	7,533	--	3	85	--	2	64
	Total	8	2	75	262	300	9,663	4	1	41	3	1	35
	AVERAGE:	6.2	25.6	76.7	194	1,088	6,553	3.5	17.0	57.5	2.7	13.6	46.0

Table 3--Summary of mountain pine beetle infested stands, Glacier View Ranger District, Flathead Naional Forest 1975-1977

Area	D.b.h.	Trees killed/acre			Volume killed/acre (bd. ft.)			% lodgepole pine killed			% stand killed		
		1975	1976	1977	1975	1976	1977	1975	1976	1977	1975	1976	1977
Hornet Creek #1	5-11.9	7	--	8	172	--	844	32	--	53	11	--	15
	>12	1	1	6	182	197	1,213	8	8	55	2	2	12
	Total	8	1	14	354	197	2,057	23	4	54	6	1	11
Moran Creek #1	5-11.9	--	--	9	--	--	338	--	--	6	--	--	5
	>12	--	9	8	--	995	1,378	--	38	57	--	28	37
	Total	--	9	17	--	995	1,716	--	5	10	--	4	9
Moran Creek #2	5-11.9	8	--	86	421	--	1,295	4	--	44	3	--	32
	>12	--	--	9	--	--	990	--	--	100	--	--	39
	Total	8	--	95	421	--	2,285	4	--	46	3	--	33
Red Meadow #1	5-11.9	2	7	89	81	--	968	1	3	35	1	3	33
	>12	--	--	--	--	--	--	--	--	--	--	--	--
	Total	2	7	89	81	--	968	1	3	35	1	3	33
Red Meadow #2	5-11.9	--	--	13	--	--	97	--	--	4	--	--	4
	>12	--	--	1	--	--	124	--	--	60	--	--	60
	Total	--	--	14	--	--	221	--	--	5	--	--	4
Coal Banks #1	5-11.9	5	6	43	115	121	2,413	3	3	22	2	3	20
	>12	1	3	5	125	245	647	11	24	70	10	21	62
	Total	6	9	48	240	366	3,060	3	4	31	3	4	22
Coal Banks #2	5-11.9	7	20	80	449	1,371	3,149	2	6	26	2	5	21
	>12	2	2	4	263	263	489	21	26	65	11	12	26
	Total	9	22	84	712	1,634	3,638	3	7	27	2	5	21
Moose Creek	5-11.9	--	--	17	--	--	477	--	--	13	--	--	8
	>12	--	2	17	--	277	2,227	--	5	44	--	5	42
	Total	--	2	34	--	277	2,704	--	1	19	--	1	13
Trail Creek	5-11.9	--	--	118	--	311	6,640	--	4	48	--	4	48
	>12	--	3	31	--	346	3,977	--	8	92	--	8	92
	Total	--	13	149	--	657	10,617	--	5	53	--	5	53
Winona Ridge	5-11.9	--	3	14	--	184	881	--	2	8	--	1	6
	>12	4	7	2	413	1,048	207	15	35	13	9	20	6
	Total	4	10	16	413	1,232	1,088	2	5	9	1	4	6
Cyclone Lake	5-11.9	--	2	60	--	190	1,497	--	1	16	--	1	14
	>12	--	3	1	--	329	182	--	42	28	--	18	9
	Total	--	5	61	--	519	1,679	--	1	17	--	1	14
Hornet Creek #2	5-11.9	--	18	30	--	1,688	1,464	--	28	66	--	16	32
	>12	--	7	11	--	958	1,668	--	34	89	--	15	30
	Total	--	25	41	--	2,646	3,132	--	30	71	--	13	26
	AVERAGE:	6.1	10.3	55.7	444.2	947	3,316.5	6	6.5	31.4	2.6	4.1	20.4

the lodgepole pine killed, 6 percent was killed in 1975, 6.5 percent in 1976, and 31.4 percent in 1977, a total of 43.9 percent for the 3-year period. Within areas surveyed, 2.6 percent of the stands were killed in 1975, 4.1 percent in 1976, and 20.4 percent in 1977, a total 27.1 percent for the 3-year period. Based on infested trees/acre, buildup ratio was 1:4.3 from 1975 to 1976, and 1:5.3 from 1976 to 1977. Four hundred eighty eight trees were killed in 1975, 12,493 in 1976, and 1,521,311 in 1977, a total of 1,534,292.

DISCUSSION AND SUMMARY

Mountain pine beetle populations increased to epidemic level in 1972 in Glacier National Park, and in 1974 on the Glacier View Ranger District. Since then, beetles have infested large diameter trees in susceptible stands.

More than 17 million trees have been killed in Glacier National Park since 1972. Based on buildup ratios from 1975 to 1977 and on the formula $Y' = y + bx$ (Baker 1968) where:

Y' = The potential cumulative number of trees killed predicted through 1978
y = Cumulative number of trees killed through 1977
x = Number of trees killed in 1977
x_1 = Number of trees killed in 1976
$b^1 = \frac{x}{x_1}$,

it is predicted that more than 29 million trees could be killed in 1978, bringing the cumulative tree mortality in the Park to 47,053,094 through 1978. Infestation is expected to decline where most large diameter trees have been killed, (fig. 2A) but is expected to continue at an epidemic level in stands where mortality has occurred for only 1-3 years (fig. 2B). Tree mortality is expected to increase in the Anaconda and Camas Creek drainages, and new infestation will occur between Howe Ridge and Park Headquarters. Additional tree mortality is expected in susceptible stands between Bowman and Kintla Lakes, and beetle populations will spread into susceptible stands in the North Fork area of Canada.

More than 1½ million lodgepole pine have been killed since 1974 on the Glacier View Ranger District. Buildup ratio is expected to exceed 1:5 in 1978. Based on buildup ratios from 1974 to 1977, it is predicted that more than 5 million trees will be killed in 1978.

Safranyik et al. (1974) developed a hazard rating for lodgepole pine stand susceptibility to mountain pine beetle in British Columbia. A similar hazard rating using stand age, density, size, and habitat type was prepared are areas supporting a significant lodgepole pine component >60 years old on the Kootenai and Gallatin National Forests in 1975 (Hamel and McGregor 1976a; McGregor et al. 1976).

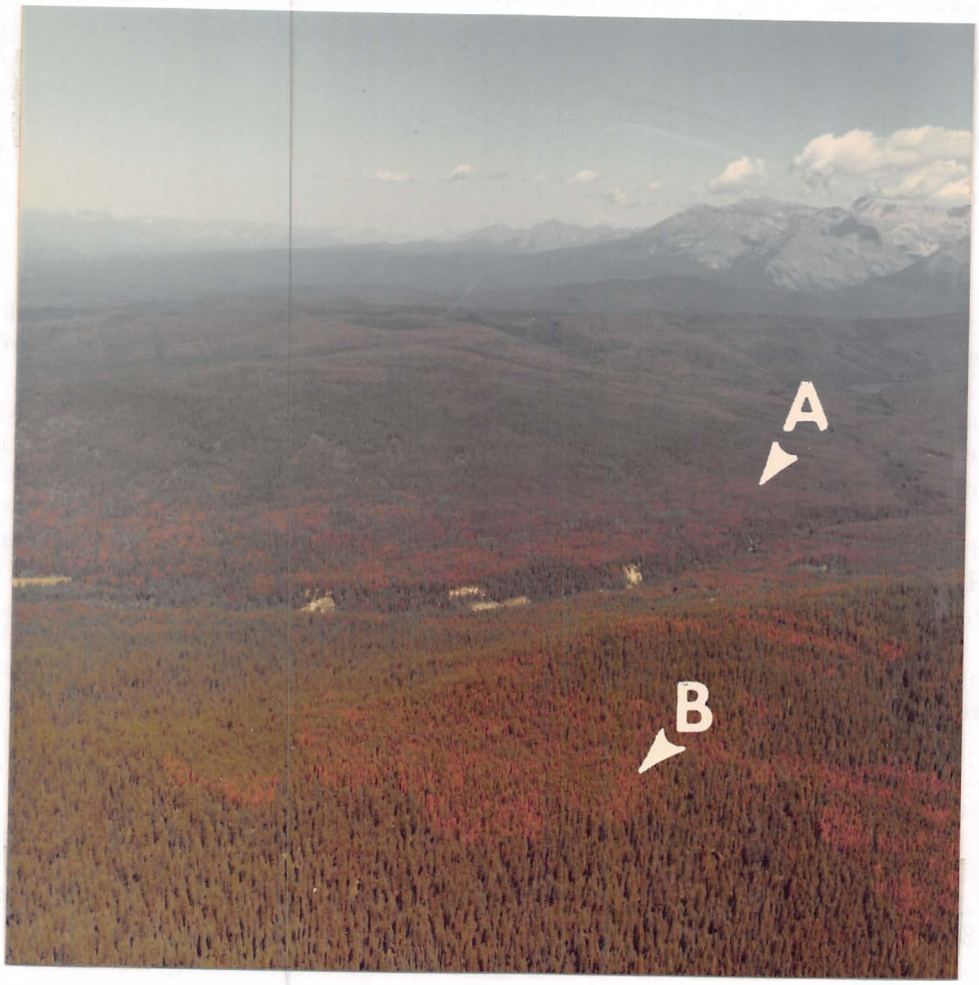

Figure 2A.--Most large diameter preferred trees have been killed; infestation will start to decline.

B.--Infestation has occurred 1-3 years; mortality will occur in 4-5 more years.

A hazard rating map (fig. 1) was prepared for lodgepole pine stands on the Glacier View Ranger District as follows:

Priority 1: Highly susceptible, stand age >80 years, trees >11 inches d.b.h., lodgepole dominant

Priority 2: Highly susceptible; lodgepole dominant, stand age <80 years, trees 5-10.9 inches d.b.h.

Priority 3: Low susceptibility; lodgepole dominant, trees <5 inches d.b.h.

Based on this hazard rating, 59,806 acres were low, and 21,827 were high.

Evaluated areas were also hazard rated for susceptibility to mountain pine beetle based on average d.b.h. of lodgepole pine >5 inches d.b.h., average age of lodgepole pine >5 inches d.b.h., and elevation (table 4) (Amman et al. 1977). Based on this system, three areas were rated high, two areas were rated moderate, and seven areas were rated low. An increase in tree mortality is expected in stands rated moderate and high hazard, and some mortality could occur in stands rated low hazard.

Glacier National Park Management Alternatives

Extensive tree mortality is predicted to occur in Glacier National Park in 1978. A decline will not occur until the beetles' food source is depleted.

Silvicultural management has not been recommended because (1) the usual stand management practices are not permitted under National Park Service policy, and (2) because of the number of infested trees, chemical treatment would not only be costly but also ineffective. Park Service policy states that "native insects and diseases existing under natural conditions are natural elements of the ecosystem. Accordingly, populations of native insects and the incidence of native diseases will be allowed to function unimpeded except where management is required (1) to prevent loss of the host or host dependent species from the ecosystem; (2) to prevent outbreaks of the insect or disease from spreading to forests, trees, other vegetation, or animal populations outside of the area where possible; (3) to conserve threatened, endangered, or scientifically valuable specimen plants or unique plant communities, or (4) for reason of public health or safety."

It appears the National Park Service has not complied with items 2 and 4 of the above. Beetles have infested lodgepole pine stands on adjacent National Forests, State and private lands, and adjacent lodgepole pine stands in British Columbia. Parts of these stands would not be infested were it not for the epidemic infestation in Glacier National Park. About 49 percent of the adjacent lodgepole pine stands were burned in 1910; 27 percent in 1926; and 24 percent in 1929. 1/ These stands were rated for susceptibility to mountain pine beetle and given a low hazard rating. Because trees are of small diameters and young age class, and because most stands are heavily stocked, they would normally not be under attack by mountain pine beetle. However, because of the large beetle populations in Glacier National Park, many burned-over stands are being killed.

Within 10-20 years, most of the dead and potentially dead trees will have fallen. Because of National Park Service policy not to utilize this material, fire hazard may become extreme within the Park and to adjacent National Forest, State, and private land. Some parts of the area may become unmanageable and unsafe for the next half century. Many uses will be restricted severely by lack of access.

1/ Personal communications, G. Wilson, Glacier View Ranger District, Flathead National Forest, 1978.

Table 4--Hazard rating for surveyed lodgepole pine stands, Glacier View Ranger District, Flathead National Forest, 1977

Area	Average d.b.h. LPP >5"	Rating	Average age LPP >5" d.b.h.	Rating	Elevation Range	Rating	Overall Rating	Hazard
Hornet Creek 1	9.5	3	145	3	4,800-5,600	3	27	High
Hornet Creek 2	9.5	3	145	3	4,800-5,600	3	27	High
Moran Creek 1	5.0	1	50	1	3,400-3,700	3	3	Low
Moran Creek 2	5.0	1	50	1	4,800-5,800	3	3	Low
Red Meadow 1	5.0	1	65	2	4,500-5,000	3	6	Low
Red Meadow 2	5.0	1	65	2	4,800-5,800	3	6	Low
Coal Banks 1	7.0	2	90	3	3,500	3	18	Moderate
Coal Banks 2	7.0	2	90	3	3,500	3	18	Moderate
Moose Creek	5.0	1	65	2	5,400-5,800	3	6	Low
Trail Creek	5.5	1	55	1	4,000-4,200	3	3	Low
Winona Ridge	5.5	1	70	2	4,300-5,000	3	6	Low
Cyclone Lake	12.0	3	105	3	4,900-5,800	3	27	High

Increased beetle-caused tree mortality will hamper movement of big game, particularly in winter game range areas.

Falling snags will increase the hazard to campers, hikers, and snowmobilers; and have a potential of causing damage to vehicles, structures, and campground facilities.

In high use recreation areas and administrative sites, green lodgepole pine 7 inches d.b.h. and larger should be sprayed to a 5-inch top with Sevimol-4® (Gibson 1977) to prevent attack by mountain pine beetle in 1978. Trees should be sprayed prior to beetle flight in July. Dead and infested trees should be cut and either removed or used for firewood.

In National Parks and wilderness areas, maintenance of a natural ecosystem has a high value. Therefore, one viable alternative for coping with a beetle infestation is to do nothing (Amman et al. 1977). However, losses are generally determined in terms of impairment of the visual resource and increased costs to maintain convenience and safety for users. Fire is an integral part of the ecology of lodgepole pine forests, and along with mountain pine beetle, it is largely responsible for maintenance of lodgepole pine as a widespread forest type. In many parks and wilderness areas, natural fires have been effectively suppressed while bark beetle infestations continue to devastate large stands that are becoming susceptible. Eventually, dead fuels accumulate and large, hot fires occur. Such fires are normally more destructive than the natural fires that would have otherwise occurred, and they also intensify and perpetuate future extremes in the mountain pine beetle/fire interaction (Cole 1977).

To moderate this cycle, a conscientious program of fire management and prescribed burning should be carried out. It should involve reliable surveys and maps of stand age, size structures, and fuels. With such data, plans can be developed to allow fires to burn under "supervision" to create a mosaic of young stands within the extensive areas of large timber that have developed from past wildfires. Prescribed fire can be used to more quickly return these ecosystems to their natural balance with fire. Prescribed burning offers real advantages over trying to manage naturally occurring fires in such high hazard situations as these mountain pine beetle infested areas. A program of prescribed fire can take advantage of optimum burning conditions for managing size of burns while achieving fuel reduction objectives (Cole 1977).

Suggested Management on the Flathead National Forest and State and Private Lands

Infested stands, and stands that have a high potential for being infested can be managed in several ways depending upon land use objectives and whether stands are pure, even-aged, or pure uneven-aged, and mixed species stands (Amman et al. 1977; Cole 1977).

Recognizing that the beetle concentrates heavily on large diameter (>8 inches d.b.h.) and older age trees (80 years old+), continuous forests can

be broken up by small clearcuts. This will result in different age and size classes, and reduce the amount of area likely to be infested at any one time. When individual stands approach high risk conditions, they should be harvested. Where composition is pure lodgepole pine and form is even-aged, practices can be limited to (1) stocking control in young stands; (2) organized clearcutting in blocks to create age, size, and species mosaics from mature stands; and (3) salvage cutting to reduce losses in stands under attack (Cole 1977). Since large acreages are infested, there is a need to examine lodgepole pine inventory data to identify commercial forest land for; (1) currently vulnerable, but not yet infested stands, and (2) those that will reach vulnerable size and phloem thickness within about 15 years.

When scheduling block cutting on sites where probability of loss is high, future losses can be prevented by regeneration of sites to patterns of alternating species among blocks or mixed species within blocks (Cole 1977).

Sanitation salvage cutting (Safranyik et al. 1974) reduces mountain pine beetle populations by destroying broods prior to emergence. This will only delay losses in susceptible stands, since enough beetles are missed to continue the epidemic.

Many uneven-aged lodgepole pine stands occur as mixed species stands. They contain a mature to overmature lodgepole pine overstory and an understory of a mixture of shade tolerant species and some younger lodgepole pine. Another common situation is one or more other species occurring in the overstory with lodgepole pine and climax species in the understory. Mature stands which are uneven-aged or mixed with large lodgepole pine in the overstory can be clearcut as a preventive, or if already infested, losses can be reduced by salvage cutting. Immature stands are candidates for stocking control, with species discrimination possible in mixed species stands (Cole 1977).

Discrimination against lodgepole pine is possible in older mixed stands through partial cuts in which only the susceptible lodgepole pine is removed.

Partial cutting of large diameter lodgepole pine will reduce mountain pine beetle infestation potential of susceptible stands (Hamel and McGregor 1976b; Cole and Cahill 1976; Hamel 1977). Amman (1976) suggests the use of partial cuts for management of mountain pine beetle where timber values are primary where (1) a small proportion of the trees are lodgepole pine having the large diameter-phloem thickness conducive to beetle buildup, and (2) where enough residual trees would remain to maintain productivity. Cole (1977) suggests that stands meeting these conditions include only a small portion of the stands susceptible to mountain pine beetle infestation. If losses are to be reduced in stands where only a small proportion is susceptible during any one infestation period, maintaining adequate growing stock may require a subsidy of development costs such as road building.

Susceptible lodgepole pine stands will not maintain good productivity when either partially cut or attacked by mountain pine beetle unless the residual stand is less than 50 years old. Beyond this age, periodic annual increment steadily declines for most lodgepole pine. In such stands, overstory removal may be better than partial cutting for growth of the understory. Future productivity could still be seriously reduced by logging damage, dwarf mistletoe infection, and windthrow--depending on which cutting practices are used (Alexander 1975).

For the above reasons, managers should be cautious in use of partial cutting where maintaining a sustained timber productivity is desired (Cole 1977).

Partial cutting can be applied as a last resort to after-the-fact salvage of beetle-killed trees. An increased utilization of sound material and a degree of direct control of beetle populations by removing beetle-preferred trees would buy time to accomplish preferred block cutting.

When implementing green tree sanitation salvage, two factors must be carefully considered to avoid doing more damage than the mountain pine beetle would.

1. Only those trees that are preferred by the beetle should be removed. Guidelines have been developed by Cole and Cahill (1976), Amman et al. (1977).

2. Beetles appear to select faster growing genotypes in a lodgepole pine stand over slower growing ones, consequently, also by green stand sanitation salvage. In a natural stand, fast growing genotypes will be maintained despite the mountain pine beetle. Because they are represented in stored seed of serotinous cones, they will be naturally regenerated by fire. In green stand sanitation, seed should be salvaged from the more vigorous, larger trees, and regenerated on-site (Cole 1977).

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MOUNTAIN PINE BEETLE HAZARD MAP

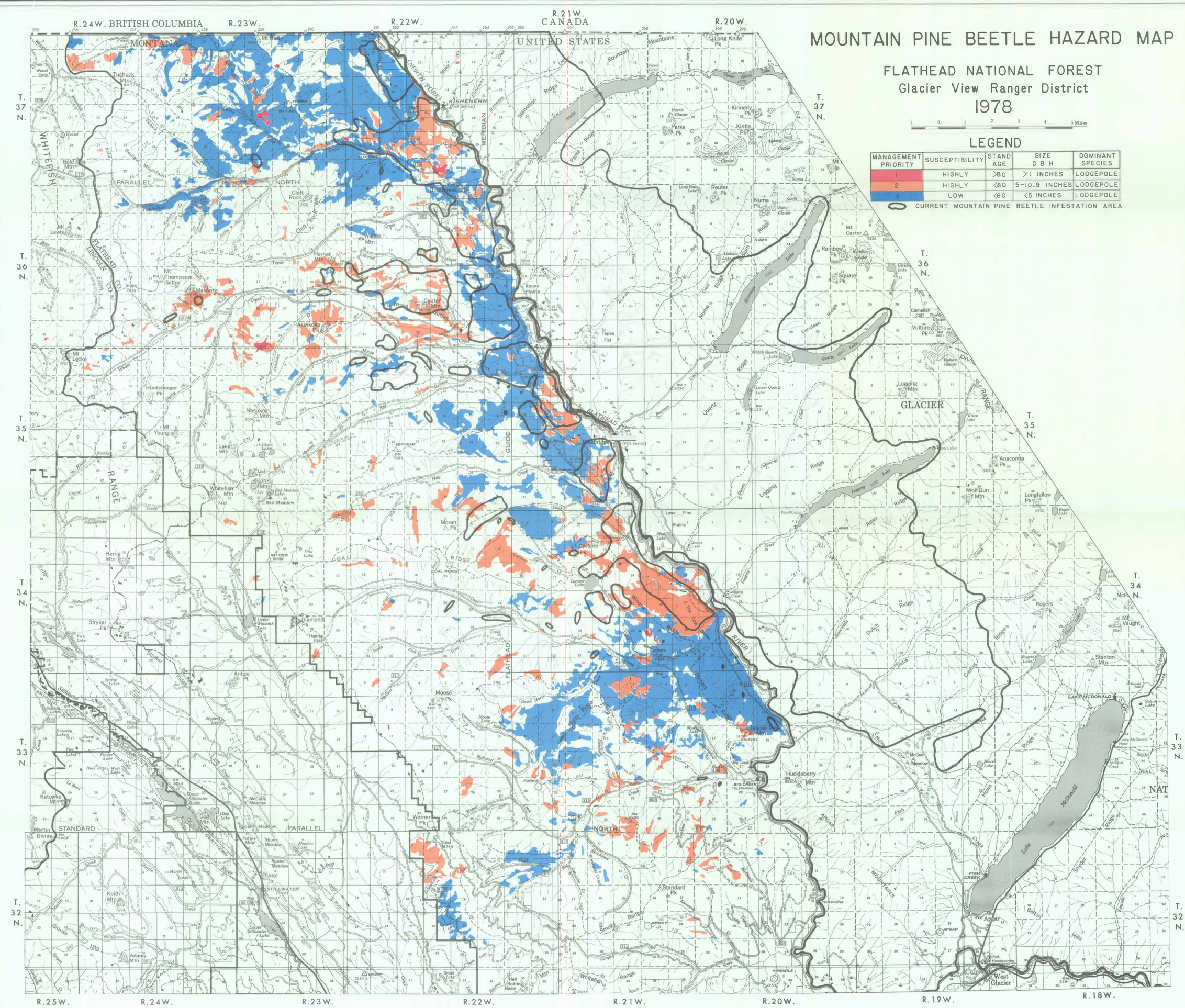
FLATHEAD NATIONAL FOREST
Glacier View Ranger District
1978

0 1 2 3 4 5 Miles

LEGEND

MANAGEMENT PRIORITY	SUSCEPTIBILITY	STAND AGE	SIZE D B H	DOMINANT SPECIES
1	HIGHLY	>80	>11 INCHES	LODGEPOLE
2	HIGHLY	<80	5-10.9 INCHES	LODGEPOLE
3	LOW	<60	<5 INCHES	LODGEPOLE

CURRENT MOUNTAIN PINE BEETLE INFESTATION AREA



R-I CARTO